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# TRIALS OF THE SOUTH AFRICAN LOCUST FUNGUS IN INDIA.

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CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1907.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

# REPORT

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# *TRIALS OF THE SOUTH AFRICAN LOCUST FUNGUS IN INDIA.*

IN past years several trials have been made in India of the South African Locust Fungus for the destruction of locusts. Tubes of the fungus were obtained from South Africa by the Imperial Bacteriologist in 1899, and the supply was propagated at the Mukhtesar Bacteriological Laboratory for distribution to officers for testing its effects on the occurrence of locust plagues. The results of these trials, which are reported in the annual reports of the Imperial Bacteriologist for 1898-99 to 1902-03, were negative, and in 1902 the Government of India decided to discontinue the issue of the fungus tubes, pending the result of further investigation and experiments. The trials by Stewart Stockman in 1902 on grasshoppers in the Central Provinces were also unsuccessful (Agricultural Ledger No. 3 of 1903). In consequence of a recommendation by the authorities of the Royal Botanic Gardens, Kew, the Government of India directed that further laboratory experiments should be made with a view to testing the efficacy of the South African Locust Fungus. These experiments, which were conducted at the Pusa Research Institute jointly by the Imperial Mycologist and Entomologist, are recorded in the following report.

Six tubes of "locust fungus" were received through the kindness of C. Fuller, Government Entomologist, Natal, on February the 10th, 1906. On examination, the tubes were found to contain pure cultures of *Mucor exitiosus* Massee, the species which has been determined

at Kew to be that utilised in recent years for the destruction of locusts in South Africa, though there is some evidence to show that another fungus, *Entomophthora Gryllii* Fres., was used in some of the earlier work.

Immediately on receipt, the vitality of the cultures was tested, and vigorous growths of the characteristic greyish fungus, producing enormous numbers of spores on sporophores buried in the mycelial web, were obtained on nutrient agar, bread and other media.

The experiments on the Bombay Locust and the Black Spotted Grasshopper were made during the end of April and first part of May, 1906, the temperature range in the laboratory (where experiments I, III and IV were carried out) being from 80° to 86° F. during the period of experiment, and the air very dry. The experiments on the North West Migratory Locust and the Rice Grasshopper were carried out in July, the temperature being slightly higher than before and the relative humidity during the time of the experiment varying from 80 to 95 per cent. (taken at 8 A.M. daily). The atmospheric conditions in July were those typical of the Monsoon period in Behar, and were particularly favourable for the growth of the fungus.

### I.—Experiments on the Bombay Locust (*Acridium succinctum* Linn.) and the Black Spotted Grasshopper (*Acridium æruginosum* Burm.)

**Experiment I.**—Five locusts, (including both *Acridium æruginosum* and *A. succinctum*) were taken. One of each species was wounded, and a portion of living mycelium, rich in spores, introduced into the wounds. A third was made to bite a platinum loop full of mycelium and spores. All were confined together in a large glass jar in a moist atmosphere, in which a small bread culture producing copious spores was also introduced. The two wounded locusts died within a week, but the other three remained healthy for seventeen days. After the death of the two wounded ones, their bodies were left for several days in the jar, in order to induce the production of spores of accentuated virulence. It is well known that many parasitic organisms, both bacteria and fungi, lose their virulence when cultivated artificially for any length of time. Though this has not been mentioned in connection with the locust fungus, the possibility suggested

itself. In such cases virulence may be again increased by passing the parasite through the body of its usual host. The attempt, however, failed in this instance, for though the inoculated locusts died, the fungus could not be recovered from their bodies and appeared on examination of one specimen to have made no growth. Though moulds appeared on the surface of the dead insects, *Mucor exitiosus* was not amongst them. Even if spores were formed on the dead bodies and escaped notice, they failed to infect the three remaining locusts, which were under observation for a sufficient time to have shown the effect if they had become infected. The death of the two inoculated locusts is to be ascribed to the wounds, not the fungus.

**Experiment II.**—One of the dead locusts (*A. succinctum*, from experiment I) was introduced into the large cage in the insectary containing a number of locusts both *A. æruginosum* and *A. succinctum*. Some of these died from time to time during the following fortnight, but the mortality was no greater than was to be expected in the case of insects in captivity, and the examination of dead ones did not in any case show the presence of the fungus.

**Experiment III.**—Three locusts (*A. æruginosum*), reared from the egg, were placed in a glass vessel in a moist atmosphere with the dead body of one of the same species, which had died during experiment II. All three remained healthy, moulted and grew considerably, being released after a fortnight. This experiment shows that the mortality during experiment II was not due to an infectious disease capable of spreading from one locust to another.

**Experiment IV.**—One locust of the same species as the last and also reared from the egg was confined in a small vessel in a moist atmosphere. On the second day after it was introduced, a single leaf of cotton well rubbed with living spores was given as food. The whole was eaten by next morning. The locust grew, moulted and was released in full vigour after a fortnight, twelve days after it had eaten the spores.

### ii.—Experiments on the North West Migratory Locust (*Acridium peregrinum* Oliv.)

**Experiment V.**—Two healthy locusts were wounded and portions of a vigorous culture one week old from agar, inserted into the wounds. Both were dead in two days, the death being sufficiently

explained by the wounds. The object of this was as before to secure spores of accentuated virulence on the locusts themselves. In five days there was a copious growth of mould on the bodies, from which the locust fungus was recovered. One was now put in a small cage with three healthy locusts, received from the insectary on July the 13th, and kept in captivity. Of the three locusts one died after six days, a second after eight and the third in nine. The latter was apparently drowned in the water kept in the bottom of the cage. In the second traces of the locust fungus were detected.

**Experiment VI.**—One of the dead locusts from experiment V (that which had died after eight days in the presence of the fungus) was transferred to a fresh cage with two healthy locusts from the insectary on July the 28th. Both remained healthy and were released on August the 5th, nine days after the introduction of the dead locust.

**Experiment VII.**—Numerous healthy locusts in one of the cages in the insectary were sprayed on July the 13th with spores suspended in water from an agar culture one week old. Two died in the next three days, but the fungus could not be discovered after incubating their bodies. The remainder were healthy on the 25th, when observations ceased. It should be mentioned that, in addition to thoroughly spraying the locusts themselves, their food plants were sprayed with spores on the 14th, so that they were exposed to both internal and external infection.

### III.—Experiments with the Rice Grasshopper (*Hieroglyphus furcifer* Serv).

**Experiment VIII.**—Eleven rice grasshoppers were received in a cage from the insectary on July the 26th. On the same date all were copiously sprayed with spores from a 20 days' old agar culture suspended in water. The leaves of paddy on which they were feeding were also sprayed. On August the 5th when the experiment terminated all were strong and several had moulted (a stage when they would be particularly susceptible to infection, if it occurs through the integument).

**Experiment IX.**—One rice grasshopper was fed with leaves which had been brushed with spores and mycelium on the same date. After nine days it was healthy and was released.

## CONCLUSIONS.

The above experiments show that the fungus does not appear capable of making a good growth, even when inoculated into wounds, on *A. æruginosum* or *A. succinctum*, but does grow on the North-West Migratory Locust (*A. peregrinum*) to some extent; that the spores may be eaten with impunity by all the species tested; and that locusts, living in a moist atmosphere charged with spores, flourish even when sprayed with the spores. The deaths of the four locusts directly inoculated in experiments I and V were doubtless due to the wounds, which would interfere with respiration. The deaths in experiments I, II and V were not due to anything capable of transmission to healthy locusts, as was found by experiments III and VI.

The only indication of success in any of these experiments is the death of the three North-West Migratory Locusts in experiment V. As against these deaths being due to the fungus, are the facts that in experiment VI the dead locusts were proved incapable of transmitting infection, and that no trace of the fungus could be discovered on the dead bodies, which were incubated, except on that used in experiment VI. The two deaths in experiment VII are probably no more than the usual mortality to be expected from insects in captivity. From these also the fungus could not be recovered. It is clear that even were any of these results with *A. peregrinum* due to the action of the fungus, the method is too uncertain to be of any assistance in the field, where nothing but the most virulent infective power is likely to be of value. The conditions in nature are much more in favour of the insect, and against the fungus, than those under which the experiments were made, and if we can only anticipate a small percentage of infections the method will certainly fail. Against the Bombay Locust, the Black Spotted Grasshopper and the Rice Grasshopper, it is entirely useless.

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G. I. C. P. O.—No. 60 I. G. Agri.—7-6-07.—1,910—P. M. M.